

PROCEDURES

BUTT FUSION

3.0 PURPOSE

This section identifies the procedures for performing butt fusion of polyethylene pipe and the handling and care of the equipment utilized to perform butt fusions.

3.1 GENERAL

- A. Butt fusion is used to make end-to-end joints between “butt” or plain end pipes and fittings that have the same outside diameter and like wall thickness.
- B. Fusion tools and equipment must be correct for the job, and in proper working order.
- C. Individuals performing polyethylene pipe joining must be qualified in the procedure being utilized or directly observed by an individual that is qualified.
- D. Pipe and fitting surfaces must be clean and properly prepared.
- E. Heating tool surfaces must be clean, undamaged and at the correct surface temperature. Heat may not be applied with a torch or other open flame.
- F. Any connections to dissimilar material shall be made with approved electrofusion fittings, mechanical fitting or other approved coupling.

3.2 POLYETHYLENE BUTT FUSION PROCEDURE

A. **Before You Start:**

1. Inspect pipe lengths and fittings for unacceptable cuts, gouges, deep scratches or other deleterious defects. Damaged products shall not be used (cuts, gouges, or scrapes deeper than 10% of the pipe wall thickness).
2. Toe-in or necking down is normal at pipe ends, but may need to be removed for socket fusion, or butt fusion to fittings.
3. Remove surface damage at pipe ends that could compromise the joining surfaces or interfere with fusion tools or equipment.
4. Be sure all required tools and equipment are on site, in proper working order and fueled.
5. The pipe and fitting surfaces where tools and equipment are fitted must be clean and dry. Use CLEAN, dry, non-synthetic (cotton) cloths or paper towels to remove dirt, snow, water and other contamination.
6. Shield heated fusion equipment and surfaces from inclement weather and winds.

PROCEDURES

BUTT FUSION

A temporary shelter over fusion equipment and the fusion operation may be required.

7. Relieve tension in the line before making connections.

When joining coiled pipe, making an s-curve between pipe coils can relieve tension. In some cases, it may be necessary to allow pipe to equalize to the temperature of its surroundings. Allow pulled-in pipes to relax for several hours to recover from tensile stresses.

8. Pipes must be correctly aligned before making connections.
9. Cuts of pipe sizes 2" or smaller may be made using a ratchet single blade style cutter, or a guillotine style cutter. Wheel type tubing or pipe cutters should be used on sizes greater than 2" in diameter.
10. All points on both heating tool surfaces where the heating tool surfaces will contact the pipe or fitting ends must be within the prescribed minimum and maximum temperatures and the maximum temperature difference between any two points on the heating tool fusion surfaces must not exceed 20°F (11°C) for equipment for pipe smaller than 18-in. (450 mm) diameter, or 35°F (19°C) for larger equipment. Heating tool surfaces must be clean.

C. Procedure

1. **Secure:** Clean the inside and outside of the component (pipe or fitting) ends by wiping with a clean, dry, lint-free cloth or paper towel. Remove all foreign matter. Align the components with the machine, place them in the clamps and then close the clamps. ***Do not force pipes into alignment against open fusion machine clamps.*** (When working with coiled pipe, if possible "S" the pipes on each side of the machine to compensate for coil curvature and make it easier to join.) Component ends should protrude past the clamps enough so that facing will be complete. Bring the ends together and check high-low alignment. Adjust alignment as necessary by tightening the high side down.
2. **Face:** Place the facing tool between the component ends, and face them to establish smooth, clean, parallel mating surfaces. Complete facing produces continuous circumferential shavings from both ends. Face until there is a minimal distance between the fixed and moveable clamps. Some machines have facing stops. If stops are present, face down to the stops. Remove the facing tool, and clear all shavings and pipe chips from the component ends. ***Do not touch the component ends with your hands after facing.*** Care must be exercised when removing the shavings to prevent contamination of the faced

PROCEDURES

BUTT FUSION

ends. **Do not touch ends of pipe with bare hands, or dirty, oily rag, or gloves.**

- Align:** Bring the component ends together, check alignment and check for slippage against fusion pressure. Look for complete contact all around both ends with no detectable gaps, and outside diameters in high-low alignment. If necessary, adjust the high side by tightening the high side clamp. Do not loosen the low side clamp because components may slip during fusion. Re-face if high-low alignment is adjusted.
Caution: Over tightening the clamps may distort the pipe.
- Melt:** Verify that the heating tool is maintaining the correct temperature.

Minimum 400 degrees F – Maximum 450 degrees F. (high density PE min. 475 degrees F- max. 500 degrees F.)

When checking heater plate surfaces for proper temperature use only approved tempilsticks, approved infrared (IR) thermometer, or approved pyrometer on the face of the heater plate. Do not use tempilsticks on the plate area where the pipe will make contact. Clean surface area with a clean cotton cloth or wooden implement if surface area is dirty. (**NEVER use metal tools**) Do not use any synthetic material, which might melt when placed on the hot heater plate.

Place the heating tool between the component ends, and move the ends against the heating tool. The initial contact should be under moderate pressure to ensure full contact. Hold contact pressure *very briefly* then release pressure without breaking contact. Pressure must be reduced to contact pressure at the first indication of melt around the pipe ends. Hold the ends against the heating tool ***without force***. Beads of melted polyethylene will form against the heating tool at the component ends. When the proper melt bead size is formed, quickly separate the ends, and remove the heating tool.

During heating, the melt bead will expand out flush to the heating tool surface, or may curl slightly away from the surface. If the melt bead curls significantly away from the heating tool surface, unacceptable pressure during heating may be indicated.

Heater plate temperature shall be checked prior to each fusion to confirm that the proper temperature is obtained.

PROCEDURES

BUTT FUSION

Table 1 Approximate Melt Bead Size

<u>Pipe Size</u>	<u>Approximate Melt Bead Size</u>
1-1/4" and smaller (40 mm and smaller)	1/32" – 1/16" (1 – 2 mm)
Above 1-1/4" through 3" (above 40 mm through 90 mm)	About 1/16" (2 mm)
Above 3" through 8" (above 90 mm through 225 mm)	1/8" – 3/16" (3 – 5 mm)
Above 8" through 12" (above 225 mm through 315 mm)	3/16" – 1/4" (5 – 6 mm)
Above 12" through 24" (above 315 mm through 630 mm)	1/4" – 7/16" (6 – 11 mm)
Above 24" through 36" (above 630 mm through 915 mm)	About 7/16"
Above 36" through 54" (above 915 mm through 1300 mm)	About 9/16"

- Remove heater plate** after achieving proper melt bead:
Retract the movable alignment clamp to pull the pipe away from the heater plate. Bump the heater plate away from the stationary pipe end and carefully remove the heater plate. If softened material adheres to the heater plate, discontinue the process and restart from step 1.
- Join:** Immediately after heating tool removal, *QUICKLY* inspect the melted ends, which should be flat, smooth, and completely melted. If the melt surfaces are acceptable, immediately and in a continuous motion, bring the ends together and apply the correct joining force. **Do not slam. Apply enough joining force to roll both melt beads over to the pipe surface.**

A concave melt surface is unacceptable; it indicates pressure during heating. Do not continue. Allow the component ends to cool and start over at Step 1.

The correct joining force will form a double bead that is rolled over to the surface on both ends.

- Hold:** Hold joining force against the ends until the joint is cool. The joint is cool enough for *GENTLE* handling when the double bead is cool to the touch. Cool for about 30-90 seconds per inch of pipe diameter. *Do not try to shorten cooling time by applying water, wet cloths or other means.*

Avoid pulling, installation, pressure testing and rough handling for at least an additional 30 minutes.

Heavier wall thickness pipes require longer cooling times.

- Inspect:** Visually Inspect on both sides, the double bead should be well

PROCEDURES

BUTT FUSION

aligned, rolled over to the surface, uniformly rounded and consistent in size all around the joint, and be non-porous. The double bead width should be 2 to 2-1/2 times its height above the surface, and the v-groove depth between the beads should not be more than half the bead height. If the joint doesn't meet these requirements, cut it out and restart from Step 1.

When butt fusing to molded fittings, the fitting side bead may have an irregular appearance. This is acceptable provided the pipe side bead is correct.

It is not necessary for the internal bead to roll over to the inside surface of the pipe.

Table 2 Butt Fusion Bead Troubleshooting Guide

<u>Observed</u>	<u>Condition Possible Cause</u>
Excessive double bead width	overheating; Excessive joining force
Double bead v-groove too deep	excessive joining force; Insufficient heating; Pressure during heating
Flat top on bead	Excessive joining force; Overheating
Non-uniform bead size around pipe	Misalignment; Defective heating tool; Worn equipment; incomplete facing
One bead larger than the other	Misalignment; Component slipped in clamp; Worn equipment; Defective heating tool; Incomplete facing; Dissimilar material – see note above
Beads too small	Insufficient heating; Insufficient joining force
Bead not rolled over to surface	<i>Shallow v-groove</i> – Insufficient heating & insufficient joining force; <i>Deep v-groove</i> – Insufficient heating & excessive joining force
Beads too large	Excessive heating time
Squared outer bead edge	Pressure during heating
Rough, sandpaper-like, bubbly or Pockmarked melt bead surface	Hydrocarbon contamination

D. McElroy No. 28 Fusion Machine

1. Check and adjust hydraulic pressures per the manufacturer's manual and monograph.
2. Select and install appropriate clamping inserts for the pipe that is being fused (as required).
3. Set up Pipe supports and adjust height so the pipe is in line with the jaws. Load pipe into machine placing approximately 1" of pipe past the face of the jaws.
4. Position pipe into machine by swinging the facer into place. With the

PROCEDURES

BUTT FUSION

carriage control valve lever, move the carriage toward the fixed jaws, while watching the gap at each end of the facer rest buttons. When the pipe is in contact with the facer, this gap indicates the amount of material that will be trimmed from the pipe end. Assure sufficient material will be removed for a complete face off. Tighten the clamp knobs on the outside jaws. Hand tighten the inside clamp knobs.

5. Face the pipe by:
 - (a) Move the carriage to the right.
 - (b) Open the ball valve on the facer motor.
 - (c) Assure the selector valve handle is up in the facing position.
 - (d) Move the carriage control valve to the left.
 - (e) If the facer stalls, adjust the facing pressure so the facer continues to cut.

IMPORTANT: When facing heavy wall pipe, it may be necessary to increase the system pressure to 1000 psi.

IMPORTANT: When drag pressure exceeds 300 psi it is necessary to move the carriage to the left bringing the pipe ends into contact with the facer before opening the facer valve.

- (f) Let the carriage bottom out on facer stops. Turn facer off. Move the carriage to the right so the facer can be removed.
6. Release the trigger lock, and swing the facer out to the storage position.
7. Remove chips from pipe ends. Do not touch faced pipe ends.
8. Inspect both pipe ends for complete face off. If the face off is incomplete, repeat the steps 2, 3, &4 above.
9. Move carriage to the right to open a space large enough to insert the heater.
10. When checking heater plate surfaces for proper temperature use approved tempilstiks, approved infrared (IR) thermometer, or approved pyrometer on the face of the heater plate. Do not use tempilstiks on the plate area where the pipe will make contact. Clean surface area with a clean cotton cloth or wooden implement if surface area is dirty. (NEVER use metal tools) Do not use any synthetic material, which might melt when placed on the hot heater plate.

NOTE: Heater plate temperature shall be checked prior to each fusion to confirm that the proper temperature is obtained.

Minimum 400 degrees F – Maximum 450 degrees F. (high density PE

PROCEDURES

BUTT FUSION

min. 475 degrees F- max. 500 degrees F.)

11. Move selector valve handle down to the heating position.
12. Insert heater between the pipe ends.
13. Move the carriage to the left, bringing the heater into contact with both pipe ends. Move selector to center position.
14. After following the specified heating time, do the following:
 - (a) Shift carriage control valve to neutral position.
 - (b) Shift the selector valve to fusion position.
 - (c) Move the carriage to the right just enough to remove the heater.
 - (d) Quickly remove the heater.
 - (e) Quickly move the carriage to the left, bringing the pipe ends together under the recommended pressure.
 - (f) Allow pipe to cool under pressure according to manufacturers recommendations. (Reference Plexco bulletin no. 101 and 105Y for approximate times as these may vary due to weather conditions, and pipe diameters.)
 - (g) After the joint has cooled for the recommended time, shift the carriage control valve to the neutral position.
 - (h) Loosen all clamp knobs, and move carriage to the right far enough to open the jaw nearest the facer.
 - (i) Open the movable jaws.
 - (j) Open the fixed jaws.
 - (k) Raise the pipe using both the pipe lifts.
 - (l) Visually inspect the joint for uniform, non-porous, well-aligned double bead around its entire circumference. If the joint doesn't meet these requirements, cut it out and restart from Step 2. (Refer to Plexco Heat Fusion Qualification Guide for additional visual acceptance and rejection criteria for PE butt fusions)

E. McElroy 2LC & No. 14 fusion machines

1. Select and install appropriate clamping inserts for the pipe that is being fused (as required).
2. Load pipe to be fused by cleaning the inside and outside of pipe ends that are to be fused. Open the upper jaws and insert pipe in each pair of jaws with applicable inserts installed. Let the ends of the pipe protrude about 1/2" past the face of the jaws.
3. Adjust the pipe for facing. Separate facers are required for each pipe size. Select

PROCEDURES

BUTT FUSION

the proper facer to use and place it between the pipe ends. Squeeze the Trigger just enough to bring the pipe ends up against the facer and adjust for face-off. Lightly snug clamp knobs, but do not over tighten.

IMPORTANT: Over tightening can flare the pipe ends, causing misalignment.

4. Face the pipe ends by rotating the facer in the direction that the arrows indicate, until it bottoms out against the inside of the jaws.
5. Check the alignment of the pipe by bringing the pipe ends together and check for alignment. If high/low (misalignment) exists, adjust by tightening the high side clamp. When pipe is properly aligned, tighten both clamps simultaneously to ensure against pipe slippage.
6. When checking heater plate surfaces for proper temperature use approved tempilstiks, approved infrared (IR) thermometer, or approved pyrometer on the face of the heater plate. Do not use tempilstiks on the plate area where the pipe will make contact. Clean surface area with a clean cotton cloth or wooden implement if surface area is dirty. (NEVER use metal tools) Do not use any synthetic material, which might melt when placed on the hot heater plate.

NOTE: Heater plate temperature shall be checked prior to each fusion to confirm that the proper temperature is obtained.

Minimum 400 degrees F – Maximum 450 degrees F. (high density PE min. 475 degrees F- max. 500 degrees F.)

7. Insert heater in position with the slotted area resting on the flat, machined surface of the machine. Bring the pipe ends against the heater faces using the pipe manufacturer's time, temperature and pressure recommendations for the heating cycle.
8. After the heating cycle is completed, remove pressure on the pipe ends and let them move away from the heater. Remove the heater, being careful not to pull any melted plastic with it and quickly bring the pipe ends together using pipe manufacturer's recommended fusion procedure (Two fingers pressure on handle)
9. After approximately 30 seconds, set cam locks if so equipped, and allow for full cooling time per pipe manufactures procedure (Minimum 30-90 seconds per inch of pipe diameter). *Do not try to shorten cooling time by applying water, wet cloths or other means.*

PROCEDURES

BUTT FUSION

10. When the cooling cycle is completed, unclamp and remove the machine.
11. Visually inspect the joint for uniform, non-porous, well-aligned double bead around its entire circumference. If the joint doesn't meet these requirements, cut it out and restart from Step 2. (Refer to Plexco Heat Fusion Qualification Guide for additional visual acceptance and rejection criteria for PE butt fusions)

3.3 EQUIPMENT CARE AND MAINTENANCE

The fusion machines should be cleaned with a dry, clean rag after each use to ensure proper function. Use of a dirty machine can result in contamination of the fusion and can also inhibit smooth movement of the clamp along the guide rods due to soiled lubrication. Clamping and fitting inserts should be cleaned with a wire brush to keep the grooves from accumulating dirt and debris. This will ensure a more stable grip between the clamp and the pipe.

1. Lubrication must be applied to the guide rods whenever the moveable clamp does not slide easily along the rods. Thirty-weight (30w) oil should be applied by removing the side screws on the moveable clamp and inserting oil into the chamber.
2. Check hydraulic oil level, voltage level, and hydraulic pressures on the McElroy No. 28 prior to use.
3. Verify that the guide rods are not misaligned or damaged. This is indicated by smooth, easy movement of the moveable clamp along the rods. Check that the bushings are not worn. If there is any damage or misalignment to the machine, the machine should be repaired.
4. Keep facing tools free of dirt and other debris by wiping with a clean rag. Keep guides on larger facers clean and oiled for smooth, easy movement along the guide rods of the fusion machines.
5. Inspect blades for sharpness. Dull blades will make even, complete facing difficult. If chips, as opposed to long continuous strands, are present during facing, a new facing tool must be used. Blades cannot be resharpened; they must be replaced.
6. If heater plate is not operating within the specified heat range, adjustments may be made by turning the thermostat screw located on the heater plate. **Always** unplug the heater plate before attempting to adjust the thermostat. The heater plate must be checked after adjustment to insure the proper heat range has been attained.